

Indeed, the whole evidence is in confirmation of what has been stated by me (*Prehistoric Comparative Philology and Mythology*. London: Trubner), that under the doctrine of the four worlds, taught in the school of Pergamos, the ancients preserved a knowledge of what was known to their predecessors in Babylon. The Austral world, which in the globe balanced our world, was Australasia, as in the other hemisphere the north and south worlds were North and South America.

Thus the knowledge of this intercourse was long lost, until now we can restore a passage of many thousands of years old in the history of Australia.

ART. XIII.—*Observations of the Outer Satellite of Mars in 1879.*

By E. J. WHITE, F.R.A.S.

[Read December 4th, 1879.]

As is now well known, the satellites of Mars were discovered by Professor Hall, of the Washington Observatory, by means of the magnificent refractor of 26 inches aperture, constructed for that establishment by the celebrated makers, Alvan Clark and Son, of Boston. Deimos, the outer satellite, was first seen on August 11th, 1877, and Phobos, the inner satellite, on the 17th of the same month.

Assisted by the positions furnished by the Washington astronomers, several observers in Europe and America managed to see these minute bodies, which in the most powerful telescopes appear as mere specks of light, with no measurable disc. Estimates, however, of their dimensions have been made from the intensity of their light, from which the diameter of the inner one has been fixed at from ten to forty miles, and the outer one between five and twenty miles. A little time after their discovery the Astronomer Royal, Sir George Airy, announced the fact to us in a telegram, and a search was at once instituted with the 4-foot reflector and 8-inch refractor of the Melbourne Observatory, but our efforts were not rewarded with success.

Although the opposition which occurred on November 12th of this year was not nearly so favourable as that of 1877—the nearest approach of Mars to the earth in the former case being 44,866,000 miles, and in the latter only 35,030,000 miles—yet as elements of the orbits had been computed by Professor Hall from the whole of the 1877 observations, which, notwithstanding that the outer satellite would have made more than 600 revolutions since it was last observed, he expected would not err more than 3° in giving the place of the satellite in its orbit, it was considered advisable to renew the search, for when once the place of an object is approximately known, it is much more easily seen than in sweeping for it.

It was considered quite useless to look for Phobos, which, although brighter than Deimos, would be always so near the body of the planet as to be completely overpowered by its great amount of light. It may be mentioned that although Mars would not approach the earth so closely as in 1877, yet it would be closer than during part of the time while Deimos had been visible, for it had been observed at Washington till Mars was 55,273,000 miles from the earth. On the night of its discovery the distance of Mars was 38,769,000 miles.

Our observations were commenced on October 21st. An ephemeris was computed from *Hall's Elements* for each night, and particular attention was paid to those times when the angle of position was about 53 or 233 degrees, when the satellite would be at its greatest elongation from its primary, the distance being then a maximum, which in the present opposition would amount to 67 seconds of arc from the centre, and about 49 seconds from the limb of the planet. To provide, however, against any great error that might possibly exist in the *Elements* Mr. Ellery instituted relays of observers, so as to extend the watch throughout the night. The eye-piece employed was a negative one, magnifying 255 times; to protect the eye from the glare of Mars a bar of blackened paper about four times the diameter of the planet was placed in the focus of the eye-lens. To this was afterwards added another bar at right angles to the former, thus forming a cross, which greatly facilitated the estimation of angles of position. During the search Mars was kept completely concealed behind one of these bars.

The nights of October 21st, 22nd, and 24th were fine, but nothing could be seen. The night of the 25th was unusually

fine; still no satellite could be detected. It was remarked, however, that a star of about the sixteenth magnitude which appeared in the field got almost completely obliterated when it approached within six diameters of Mars.

The moonlight now began to interfere with the search, and advantage was taken of the interval to try a series of experiments for improving the definition by cutting off some of the extreme rays from the mirrors. Increased sharpness was thus obtained, but at the expense of so much light that the full aperture was always employed afterwards.

On the morning of November 5th, between 2h. 15m. and 2h. 30m., Mr. Turner got a glimpse of a speck of light in the position indicated by the ephemeris; but clouds soon came up, so that it could not be seen long enough to know whether it was following Mars or not. On the evening of this day the observations extended from 9h. 0m. till 11h. 30m., but nothing was then seen.

On November 6th the night was fine, with occasional hazy intervals. The best position was computed to occur a little before midnight. At about half-past twelve Mr. Turner got a few momentary views of the satellite; he sometimes thought it bright enough to measure its position. Nothing like continued vision, however, could be obtained for even a few seconds, so that all attempts at measurement were unsuccessful. I also took part in the observations of this night, but at no time could I see the satellite.

On November 13th the night was cloudy and wet till 10h. 15m., when it cleared up; soon afterwards Mr. Turner saw the same object as on the 4th and 6th instants. Attempts to measure the place were made with the micrometer, but without success. According to estimation, however, the position angle was 54° , and distance $2\frac{1}{2}$ diameters from the following limb of Mars. The observer remarks:—"The speck seen had not a sharp appearance like a small star, but a nebulous look, and I at once recognised it as the same object seen on the previous occasions. It seemed to scarcely change its position with regard to the planet, though the motion was plain enough when referred to a twelfth magnitude star, which was at the same time in the field. I feel certain this is no optical illusion."

The night of November 15th was very clear, but the images were unsteady. At 8h. 55m. the satellite was seen at an estimated distance of $2\frac{1}{2}$ diameters from the preceding limb of Mars, and angle of position 235° . I also observed the

same object with comparative ease this evening, as likewise did Mr. Grieve, the assistant workman; but no measures could be taken, for the body always disappeared when it was brought near the bars.

On November 17th the best position was near the time of sunset. The night was fine, but Mars was too low, and for part of the time obscured by Government House. Just before 9h. 0m., when it became cloudy, Mr. Turner suspected a faint speck of light in the assigned position.

The night of November 20th was very cloudy till 10h. 0m., when it became very fine; the presence of the moon, however, interfered with the observations. A few fitful glimpses of the satellite were seen by Messrs. Ellery, Turner, Grieve, and myself, but the observation was so difficult that nothing like the same certainty was felt as on the former occasions.

At the time of our last observation Mars was 46,977,000 miles from the earth; at his next opposition in December, 1881, his nearest approach will be 56,063,000 miles. This will gradually increase till the opposition of 1886, after which a diminution will take place; so that, unless we have improved optical means, I think there is little chance of seeing those very minute bodies before 1890 or 1892.

The only other observations of Deimos at this opposition which have come under my notice are those of Mr. Common, in the south of England. He obtained his first observation on September 21st, or about three weeks before it was expected to be seen with the great Washington refractor, with which the original discovery was made. Mr. Common's instrument is a silver on glass reflector, of three feet in diameter. Mr. Common estimates the error of place in the orbit to be about 15° , corresponding to 1.3 hours. The estimates of position given by the Melbourne observers are necessarily very rough, for it was absolutely necessary to keep Mars completely behind the occulting bars to see the satellite at all.
